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# **EARTHEN ARCHITECTURE HELPING THE VICTIMS OF THE 2007 FLOOD IN BANDIAGARA (MALI)**

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**Key words:** Climatic change, flood, improved traditional techniques, development

## **Abstract**

On 4 July 2007, the river crossing the city of Bandiagara overflowed due to unusually heavy rains. Within few minutes, 194 families (nearly 1,500 people), witnessed the devastation of all or part of their homes and means of subsistence. At that time, the Cultural Mission of Bandiagara and CRAterre were collaborating in the framework of the project « Renforcement des capacités locales pour une meilleure contribution du secteur de la construction au développement durable du pays dogon » (Reinforcement of local capacities for a better contribution of the construction sector to the sustainable development of Dogon country) financed by the European Union; they called upon institutions to enable them to include, as part of their activities, a contribution to the reconstruction of basic housing structures. The German organization "Misereor" and the Abbé Pierre Foundation based in France responded positively by funding the reconstruction of 20 houses for sheltering the most affected families.

The project was carried out in collaboration with the local Catholic Parish (Caritas), the municipality, the Flood Victims' Association, district chiefs, and the prefecture. A Committee was established to carefully select the 20 recipient families, which would commit to collecting materials from their affected properties and participate in the construction-training activities implemented. This reconstruction project benefited from the results of an inventory of the building cultures in Dogon country that included the study of land plots, building typologies and construction techniques. On the basis of these principles, twenty basic houses were designed and built, each with a different plan, defined by the types of materials recovered, the priorities identified by the families and the possibilities for future extensions. The reconstruction process was an opportunity to demonstrate and train workers to master innovative flood-proof building techniques and combine them with traditional practices.

## **1. INTRODUCTION**

Due to perceptible climatic change in the Sahel over the past decade, localised torrential rains have generated a sudden and brutal rise of waters never before seen on the Dogon Plateau. On 4 July 2007, high waves burst the Yamé riverbed (a tributary of the River Níger, that passes through Bandiagara). In the town of Bandiagara, many families living along the Yamé River lost almost everything (homes, food stocks, materials, etc). In light of the seriousness of this catastrophe, volunteers brought emergency aid to ease the suffering of the victims. Within this framework, the Cultural Mission of Bandiagara and CRAterre launched the idea of a reconstruction programme for the most affected families, which would complement efforts by the municipality to provide the affected families with land to build on. After a pilot study (Léon house) that helped define the technical and financial references, a project proposal was developed and submitted to Misereor through the Catholic parish, and then to the Abbé Pierre Foundation. The project became a reality when funds were obtained for the construction of houses for 20 families affected by the floods, which – together with the pilot study family – brought to 21 the number of beneficiary families.



Fig.1 – The house built for the Adama Dramé family – AP4 (credit: Joffroy Thierry, 2010)

The complementary activity for training workers on the building sites was financed by the European Union within the framework of the project *“Reinforcement of local capacities for a better contribution of the construction sector to the sustainable development of Dogon Country”*, which had been running since 2007. On the ground, the project brought together the skills of the Catholic parish through Caritas/APH, the Cultural Mission of Bandiagara, CRAterre and the architectural firm Audex. In order to follow-up the implementation of the project, Misereor also engaged two technicians from the Bafoussam Professional Centre in Cameroon, which enabled a South-South exchange.

## 2. APPROACH AND STRATEGY FOR PROJECT IMPLEMENTATION

The underlying idea of the project was to use the reconstruction effort to demonstrate that the use of local materials, especially earth, can be compatible with resistance to adverse weather, and that this type of sustainable construction could be affordable and accessible to more people. In fact, with a budget of 3,000 Euros per family, it is indeed possible to achieve quality construction and to have enough space to re-settle families in decent conditions. The costs of construction to such a standard would also ensure favourable conditions for the extension of future homes, as well as duplication of these methods by the masons trained in improved construction techniques.

The project was also able to show how such reconstruction projects could be carried out in a sympathetic manner, while adapting to:

- the priority needs of the families in the construction programme,
- the specificities of the land and the distinct constraints of common ownership,
- the real possibilities that each beneficiary had something to contribute.

This contribution would allow us to propose certain additions to each family's construction plan (extra rooms, fencing, covered balconies, etc). Each family could choose from among:

- Participation through volunteer labour; in this case, a work-day is estimated at the same price as a labourer or mason hired for the project, and the overall is taken into account;
- Contribution of materials (re-use of recovered materials, production and supply of earthen bricks, contributions in sand, stone or other local resources, etc.),
- Financial contribution.

In this way, each family receives an identical ‘base’ financial package but can have a variety of proposed construction plans, adapted to each layout, instead of replicating any single model.

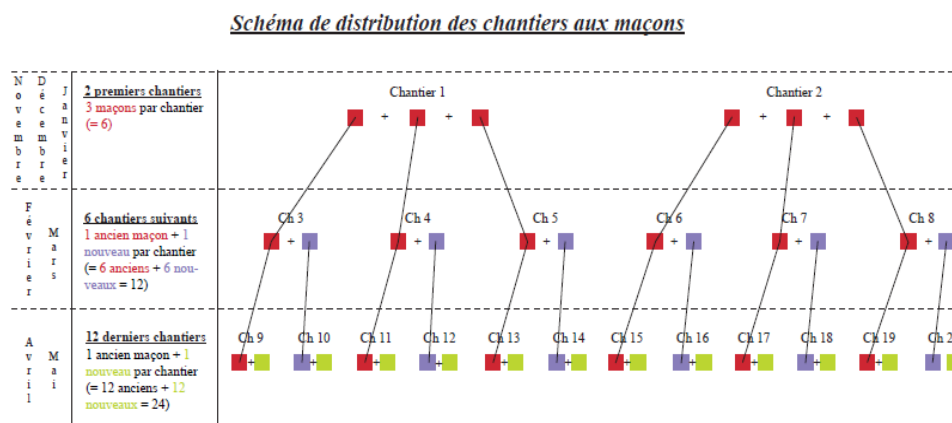
Concerning the strategy for the dissemination of knowledge, it was envisaged that the project would have three main phases; at each stage, masons would be trained to independently take charge of a site at the next phase.

Phase 1: Pilot sites for two families. These site projects would support training, ie. “training project”. Each of the two site projects would be executed by a team of three trainee masons, each of whom would become trainers on the next site project, with the support of technicians hired for the project.

Phase 2: The idea was that the head masons of six projects would be those who were trained in Phase 1; a newly recruited mason would have to help them in their work and thus benefit from their experience to learn and in turn become the head mason in the last phase.

Phase 3: This last phase of the project involved the last 12 families, and at this stage a dozen masons who, theoretically, were autonomous enough to lead the process.

This “phasing” also allowed us to put in place a training strategy that resulted in 12 masons and 24 labourers (each mason being accompanied on the site by two labourers). This strategy is illustrated in the diagram below:



**Fig.2 – Construction – training strategy (credits: Laure Cornet, 2009).**

## 2. SELECTION OF BENEFICIARIES

Since the available funds would not be able to assist all the victims, the organisations in charge of the implementation of the project established 12 criteria that would enable the most vulnerable families to access the resources of the reconstruction assistance project. A call for applications was launched on 28 September 2009 through posters at relevant buildings and services such as the Town Hall, the Prefecture, “Conseil de Cercle” (District chiefs), “APH”, etc., as well as through announcements on local radio stations. Finally, a meeting took place with the area chiefs and the Flood Victims’ Association. An application dossier was developed to facilitate the evaluation of candidates based on the established criteria.



In order to select the beneficiaries from among the 44 applicants, a selection committee was established, comprising technical services representatives from Urbanism and Settlement, Decontamination and the Fight against noise and pollution, from the Municipality of Bandiagara, Caritas/OPAH Bandiagara, the Flood Victims Association, the Cultural Mission of Bandiagara, and from the architectural firm Audex.

The establishment of the final list of beneficiaries was made in the course of three meetings and site visits facilitated by the City Council. The results were announced through posters and on local radio, following which the 20 beneficiaries were invited to the Cultural Mission to be briefed in more detail on:

1. The voting and selection process;
  2. The overall principles for the works, ie.:
    - a. A fixed financial package for each family and the possibility to enhance the construction plans depending on each family's own contribution;
    - b. The possibility for each family to define the plan that best suits it according to their specific needs within a range of proposed features (bedrooms, living rooms, covered balconies, verandas, latrines, fencing, etc.);
    - c. The availability of local materials (esp. earth), etc.
  3. The division of the reconstruction programme into several phases and the impending construction works at the first two projects/building sites;
  4. The procedures, especially how the work was to be organised with them;
- The meeting also had a Question and Answer session.

### 3. PERSONALISED DESIGNS

This work was carried out on the basis of an inventory of building cultures in Dogon Country, previously carried out by the Cultural Mission, NGO Radev-Mali and CRAterre within the framework of the EC-funded project “*Reinforcement of local capacities for a better contribution of the construction sector to the sustainable development of Dogon Country*”. This enabled us to focus on the bigger elements, at the level of contemporary local practices for land (plots) use, as well as on construction typologies, including in Bandiagara.

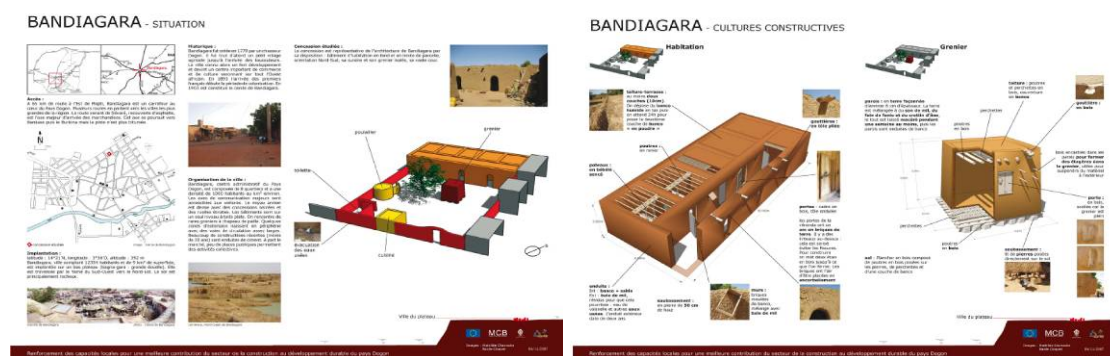


Fig.3 – Left: Analysis of urban fabric in Bandiagara and traditional organisation of a house plot. Right: Description of house structure (credits: Mathilde Chamodot, Basile Cloquet, 2008).

Using the results of this work, base models were conceived: one-bedroom, two or three rooms, balcony, covered veranda, bathroom unit, and kitchen. Aside from these models, numerous combinations could be offered. Concurrently, each model was costed, which also made it possible to make quick estimates on the price of planning proposals that would come out of the discussions with the beneficiary families. A table of costs was developed, allowing us to make variations based on different parameters: the amount of each component selected for the construction (eg: one, two or three rooms, one kitchen or none, one bathroom unit), as well as the type of finishings (sealant, screed, etc.). Despite the amount of time it took to put this tool in place at the beginning of the project, it was indispensable for customising the plans.

These specificities of each beneficiary family – and also of the environment and the urban framework within which the constructions will happen – have, since the formulation of the project, caused us to think about developing a participatory effort that would allow us to take into consideration:

- the priority needs of each family
- their capacity to contribute (financially or in kind)
- the necessity to protect against strong winds (and rain) from the East
- the orientation, nature (rocky or not), the slope and the characteristics of common land ownership (water outlets, buildings on the edge of plots, etc.)

To this end, the representatives of the relevant technical organisations (Cultural Mission, CRAterre and the architectural firm Audex) organised a series of individual meetings and site visits with the beneficiaries so that they could express their needs and priorities, and also give their opinions on the proposed plans and the actual implementation strategy.

#### **Description of the process for designing plots distribution:**

- A first meeting made it possible to list the particular needs of each family, to identify the priorities, to take note of some technical or aesthetical preferences (rendering, types of windows), optional additions of other details (eg. ventilation duct) and to be conscious of potential recommendations. It was also an opportunity to confirm the commitment that each family pledged in their application, so as to better assess the amount needed and the additional funding possibilities.
- Working time (without the family) was then set aside to develop the proposals to be submitted to the families, keeping in mind their demonstrated needs and the financial package available to the family based on their own contribution.
- A second meeting took place, whereby each family was presented with the various proposals that fit within the given budget (at least two different choices, and sometimes as many as five, given the possible combinations). The decision was then made with the help of a prepared model, allowing the families to get a better idea of their construction project and how it would fit into their plot.
- The ratification of one proposal was then made by the family, either on the same day, or after consultation with other family members.
- The family was invited one last time to the Cultural Mission to sign a contract.



Fig.4 – Work sessions with the beneficiaries (Credits: Laure Cornet, 2009)

Each “dossier family” was finally established with the following documentation:

- Application
- Needs/recommendations and specific choices
- Proposal of options
- Ratification/selection of one of the proposed options
- Estimated budget according to the options selected by the family
- Technical file (plans) – building permit

- Model and photo
- Contract between the family and the partners (and, eventually, receipt for the funds)
- Construction follow-up forms
- Eventually: the family's budgetary participation, kept at the Cultural Mission of Bandiagara

The dossier remains available for consultation at all times by the beneficiary family; especially the model, to which everyone can easily refer.

#### **4. DESCRIPTION OF THE MAJOR BUILDING PHASES**

We must keep in mind that the works were initially planned in such a way as to have three phases, which would allow for the training of masons and transmission of expertise during the different building stages. The order of the construction was not left to chance, and a strategic choice was made. The first two site projects and plots were selected because of their proximity to the Cultural Mission of Bandiagara and their proximity to each other, to facilitate movement by the technicians between the projects and follow-up.

Another criterion was added to this: the first two families to benefit from the programme were also among the most needy; as such, it was decided to prioritise widowed women with no resources. The second group (six projects) was established in the same way: plots located in a restricted area and families in the most difficulty. The third phase, which in theory would require fewer follow-ups, involved the remaining 12 families.

It is important to note that the training strategy was not able to completely fulfil its objectives. The masons trained in the first and second phases of the works exhibited varying levels and apprenticeship ability. As such, at the end of the second phase, those masons who were sufficiently independent and competent were allocated site projects, whereas the others stayed in their role of assistant.

##### **First phase:**

The procedure with the first two families was launched at the beginning of November 2009 and the two (2) site projects (on plots O/6 and R/1) were started soon thereafter, on 19 November. The training element was also primarily made possible through support of a technician from Audex and the Cameroonian foreman made available by Misereor. The technician from Audex, having worked closely with CRAterre since the end of 2007 within the framework of the EC-funded programme, already participated in several works of this nature (in terms of local material, esp. earth), and was thus able to become a trainer at this stage.

Through some sessions on theory by the CRAterre expert at the beginning of the works, the masons and the supervisory staff were reminded of some basic principles. In fact, the works should have begun with the professionals who had already benefited from training sessions within the framework of the EC-funded programme, and who were already skilled in improved earthen construction techniques. It was important to count on competent masons, who were able to transmit their skills.

##### **Second phase:**

The second phase of six building projects took off on 22 December 2009. At this stage, six extra masons joined the main team, bringing the team to a total of twelve masons; each builder working with two labourers. Therefore, about 36 professionals were working simultaneously, which explains the speed of the works. Mid-way through the project, a session of technical review was carried out, so as to emphasise some details that were still not being observed and, as such, may have been misunderstood. This short training, which was both theoretical and practical, was organised by leaning heavily on the technicians on site, so as to reaffirm their role as trainers of the builders, and as the ones who would ensure the proper execution of the works.

A supplementary training session was organised during this phase, in February 2010, for the construction of kitchens that were built without wood, and whose roofs were domed, made from unfired earthen bricks (adobe). The transmission of skills having been done, the local team carried out the next cupola projects independently.



Fig.5 – Construction of cuploas (Credits: Laure Cornet, 2010)

### **Third phase:**

This last phase of execution was launched on 8 February 2010, simultaneously with the second round of works on the first eight contracts. The work plan was developed with the aim of finishing the construction and handing over the keys to the beneficiaries before the onset of the rainy season. In order to allow enough time to dry before plastering the houses, the project advanced slowly. It was first of all preceded by the execution of the main works of the last houses, then the complete execution of the finishing (plasterwork, interiors and exteriors, floors, balconies, placing of doors and windows) of the first eight houses and then of all the remaining houses.

Unfortunately, at this stage, the pond from which the water was drawn ran dry. To overcome this obstacle, it was necessary to transport water from a source about 5km from the town of Bandiagara. This was made possible thanks to the support of the Catholic Mission that provided a mobile tanker, with the pick-up of the Cultural Mission. This exemplified the importance of planning the projects well from the beginning, when faced with this type of climate. In this way the building works, which used a lot of water, were carried out before embarking on the finishing touches. This was also what was done, from the beginning of the project, with the estimate of the number of bricks that would be required for all the building sites and the anticipated mass production of adobe just after the rainy season, so as to take advantage of the natural reserves of rainwater.

## **5. EPILOGUE AND CONCLUSIONS**

Despite some difficulties during the implementation, and a slight delay in the anticipated delivery date, all the social partners of Bandiagara deemed the execution of this project as a success. The handing-over of the keys was done right at the beginning of the rainy season (early July 2010), which also provided shelter for the beneficiaries during that time.

On the whole, the follow-up and training programme was fruitful. It is now clear that the strategy to have the builders become progressively more responsible should have been revised based on the different levels of expertise they gained; we are nonetheless



aware that an investment in training allowed us to strengthen and eventually multiply the skills for the execution of a building project by young builders.

Through the promotion of local materials and practices, the project created a lot of employment for builders, labourers, transporters, etc., which resulted in increased economic benefits for the population of Bandiagara. In addition, the construction of the buildings allowed the masons, labourers and brick builders to learn new techniques. The project thus introduced ideas and skills that are today being built upon to improve the availability of basic housing.

After the rainy season, most of the project homes were the subject of new works, executed by the families to expand their basic housing (addition of extra rooms), or to finish the funds provided (equipping the kitchen, boundary wall, etc.). The evolutionary aspect of the homes, through the integration of lintels in the masonry, allowed the placement of doors in the walls. As such, the beneficiaries could easily add rooms, economising on wall space and overall space on plots that are often home to many families.

As flood victims, their first instinct would have been to build new houses out of concrete blocks and sheet metal – which would have been smaller. Based on the experience in the improvement of traditional homes (foundations, method of execution of the basement, capillary barriers, quality of bricks, etc.), the local technicians and the families are now convinced about the potential of high quality earthen construction, suited to their own means.

It is worth noting that this acceptance was especially demonstrated by some people on projects outside this programme, who adopted technical details or proposed construction typologies. The technicians have also had some initiatives and started to apply, when they deemed fit, certain construction principles learnt in the course of the reconstruction project. This was notably the case in the construction of the boarding facility for students at the Protestant parish.

In addition, the project was visited by representatives of Delegation of the European Union in Bamako, as well as the Governor of the Mopti region, and His Excellency Mohamed El Moctar, the Minister of Culture. This visit took place on 7 May 2010, with the political and administrative authorities of the District of Bandiagara. This was good publicity to show these authorities the possibilities offered by the effective use of local materials.

As a result of its success, the reconstruction programme became known to the national television station's programming editors. A news reporting team was sent to Bandiagara by the directors of the station; this resulted in a 10-minute programme broadcast in a widely-listened to one-hour slot during the course of March 2011, and several more times in the same year.

With regard to the results and the benefits, we can say that the project fulfilled the expectations of both the partners and the participants. As concerns the beneficiaries, the flood of 2007 is now but a bad memory for them. Thanks to this humanitarian action, they were able to be housed and, above all, to have a home of their own, for their children and their parents.

This resettling was, above all, undertaken with a view to establishing a procedure for sustainable development, while strengthening the capacities of the building workers and technicians. It also provided a better understanding by the local and national authorities of the solutions offered by local materials. For the local population this project increased their resilience by decreasing dependence on foreign construction techniques and materials.



Fig.6 – Adobes ready for the self continuation of the recovery  
(Credits : Thierry Joffroy, 2011)

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## Brief bios:

Lassana Cissé holds a Bachelor of Philosophy. He has been working for more than 20 years with the Ministry of Culture and is the curator of Bandiagara Cliffs World Heritage Site. He is a member of ICOMOS-ISCEAH and is often contracted for provision of services to ICOMOS (expertise), UNESCO-WHC (periodic reporting) and for the elaboration of EU calls for projects.

Thierry Joffroy, architect DPLG, is specialised in earth construction and has been working in this field for the last 25 years. He is currently the Chairman of CRAterre, and the pedagogical coordinator of CRAterre-ENSAG post-Masters course. In 2010, he was awarded the Conservation medal of the Academy of Architecture for his work with CRAterre in the field of heritage conservation.